Docket #: S23-010

Multi-layer self-healing devices using immiscible dynamic polymers

Researchers at Stanford University have developed a multilayered immiscible polymer system that can autonomously realign its layers to facilitate the healing process following damage.

Self-healing polymers can recover autonomously from various forms of damage. Conductive or dielectric particles may be embedded within these polymers to extend their functionality. These polymers are often arranged into a multilayer configuration, in which each layer is dedicated to a specific function. All layers are typically made with the same polymer to ensure strong interlayer adhesion. Even though most of these multifunctional polymers can successfully self-heal when the layers are aligned, even the slightest misalignment could reduce the efficacy of the healing process, risking a loss of functionality.
To overcome this problem, Stanford researchers have designed a pair of immiscible dynamic polymers to create a multilayered self-healing polymer laminate with autonomous realignment ability. Adjacent layers were constructed with immiscible dynamic polymers with the same dynamic bond, ensuring interlayer adhesion, but different backbones for interfacial tension-mediated realignment after damage. Polymer blends created using this approach achieved a full self-directed structural and functional recovery after damage.

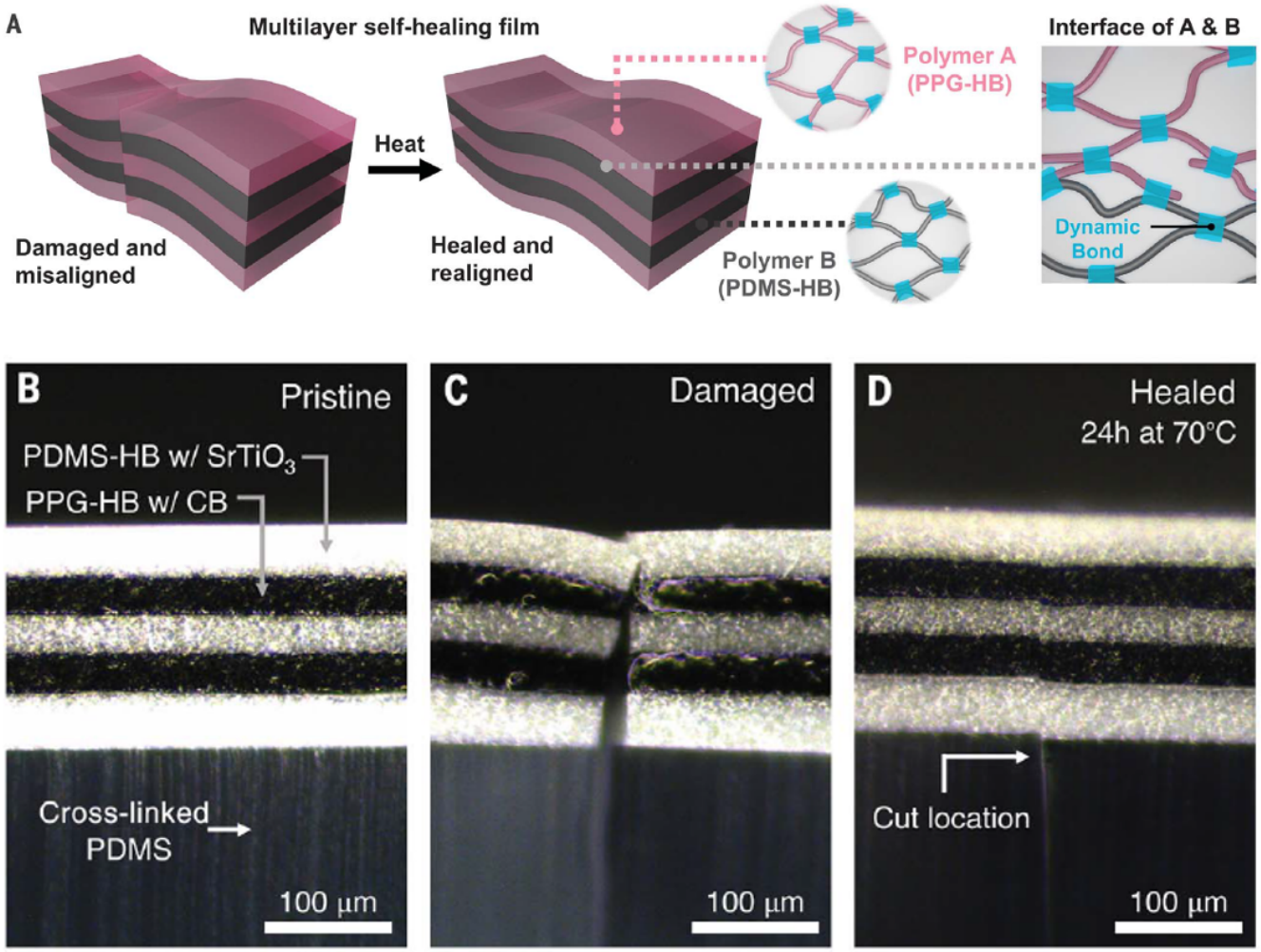

FIgure 1. A) Schematic showing the principle of surface tension–mediated realignment and healing of a fractured multilayer laminate. B) Before damage, C) after damage, and D) after healing (Adapted from Figure 1 and 4 in Cooper *et al.* (2023)).

Stage of Development

Proof of concept

Applications

- Soft robotics
- Surgical modeling
- Films and coatings for industrial uses
- Implantable flexible electronics
- Wearable flexible electronics

Advantages

- Less risk of misalignment and functional loss
- Can incorporate multiple functions
- Inspired by the human skin healing process
- Potential for countless applications with other immiscible polymers

Publications

- Cooper, C. B., Root, S. E., et al. (2023). Autonomous alignment and healing in multilayer soft electronics using immiscible dynamic polymers. *Science, 380(6648)*, 935–941.

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